USE OF ODONATA AS PREY BY SAND WASPS, *BEMBIX* SPP. (HYMENOPTERA: SPHECIDAE)

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Abstract

The sphecid wasp *Bembix minya* Evans & Matthews from southern South Australia is recorded for the first time as preying on damselflies (Odonata). Details of its nest structure and prey range are presented, as is a discussion of the evolutionary transition within the genus to utilising prey other than Diptera.

Introduction

Bembix F. is a large cosmopolitan genus of sphecid wasps comprising about 330 described species, 82 of which occur in Australia (Evans and Matthews 1973, Bohart and Menke 1976). They are often extremely common in sandy habitats such as along beaches and the dunes of arid and semi-arid deserts. With one exception (Evans 1978), species elsewhere in the world exclusively provision their brood chambers with various paralysed adult Diptera (usually muscoids, syrphids, dolichopodids and therevids) as food for a single developing larva (Evans and Matthews 1973, Bohart and Menke 1976). It is this biology and the fact that nest construction and provisioning can be observed easily that has lead to the genus being used in studies of comparative insect behaviour (e.g. Evans 1957, 1966, Evans and Matthews 1973).

Compared with other continents, the Australian *Bembix* fauna is particularly interesting in that several species prey on insect groups other than Diptera, including thynnine wasps, colletid, halictid and *Trigona* Jurine bees, myrmeleontid lacewings and Odonata (Evans and Matthews 1973, Evans *et al.* 1982). Two species have been recorded as provisioning their nests with damselflies, *B. coonundura* Evans & Matthews from Lake Violet in Western Australia, and *B. variabilis* Smith from Darwin and the Ord River near Kununurra (Evans and Matthews 1973). A third species, *B. allunga* Evans & Matthews, is known to utilise adult libellulid dragonflies at Kemp Beach near Yeppoon, Queensland (Evans *et al.* 1982). However, *B. variabilis* and *B. allunga*, both of which are widely distributed across the continent, are not obligate predators of Odonata. More commonly they prey on a wide variety of other insects, which include at least 12 dipteran families in the case of *B. variabilis*, while *B. allunga* preys on various families of Diptera and Neuroptera. In this study a fourth species, *B. minya* Evans & Matthews from southern South Australia, is also recorded as preying on damselflies. Details of its nest structure and prey range are presented, as is a discussion of the evolutionary transition within the genus to utilising prey other than Diptera.

Materials and Methods

Observations were made over a period of two days in mid-March 1993 at Wistow, 4 km south of Mt Barker in the Adelaide Hills, South Australia (Fig. 1). The nests originally were discovered by accident when a two-tonne pile of builder's sand that had been at the site for the previous seven days, was moved using a spade. Five nests were discovered, two of which were partially disturbed by the spade, while the other three were completely destroyed but recognisable by three semi-discrete groups of damselfly prey. One adult wasp and all damselfly prey were collected into 70% alcohol from a total of five nests, for later identification. Observations were undertaken every 30-60 minutes during daylight hours but when no wasp activity was observed at the end of the second day, the nests were gently exposed using a small spoon to elucidate their structure.

Fig. 1. Localities where *Bembix* spp. have been recorded preying on Odonata: *B. variabilis* on damselflies (●); *B. coonumdura* on damselflies (◆); *B. minya* on damselflies (✱); *B. allunga* on libellulid dragonflies (■).

Results and Observations

Several species of sphecid wasps, including *B. minya*, had constructed nests in the pile of builder's sand described above. All nests were on the north-western side of the sand pile and the entrances about 50 cm from ground level. The two partially disturbed nests had slightly curved entrance tunnels, estimated at 20 and 25 cm in length and angled downwards at about 30° to the horizontal. At the end of each tunnel a single elongate brood chamber was found that was horizontal and about 10-12 cm in length (Fig. 2). One chamber contained 15 damselflies, comprising two obvious species based on colour differences, and a single small *Bembix* larva. The other chamber contained 19 damselflies, again comprising at least two species. These prey were retained with the damselflies from the other three nests and totalled 79 individuals, which later identification revealed to comprise four species, two coenagrionids and two lestids (Table 1).

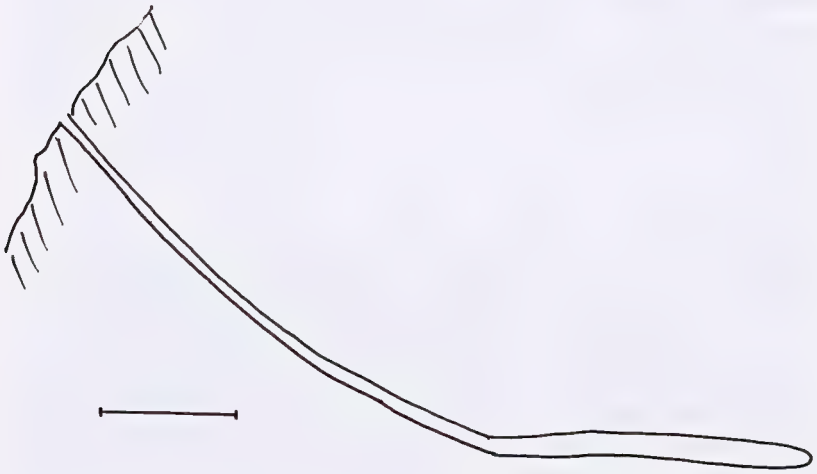

Fig. 2. Lateral aspect of the nest of *Bembix minya* showing elongate brood chamber (scale line = 5 cm; tunnel diameter not to scale).

One adult *B. minya* was collected from one of the two partially disturbed nests and no other individuals were recorded at the sand pile over the next day and a half. It is therefore possible that all five nests were constructed by the one adult female and some of them had been fully provisioned and sealed off. Given that 79 damselflies were recovered from the five nests, it seems reasonable to assume that this species provisions its brood chamber with an average of 16 prey items, a figure commensurate with the 15 and 19 prey recorded from the two partially disturbed nests.

Extensive searching of the area showed that the closest source of damselflies was from two farm dams, one approximately 200 metres to the west of the nest site and the other about 380 metres to the south-east. Several other dams were located 400-600 metres in various directions. A small number of damselflies were seen flying over the water surface of the closest dam. Several individuals were netted and these were later identified as *Austrolestes analis* (Rambur) and *A. annulosus* (Selys), the two commonest species collected by *B. minya* (Table 1).

Table 1. Damselfly species recorded from five nests of *Bembix minya* at Wistow, South Australia.

Damselfly prey	Number of individuals
Coenagrionidae	
Ischnura aurora (Brauer)	1
Xanthagrion erythroneurum (Selys)	17
Lestidae	
Austrolestes analis (Rambur)	30
Austrolestes annulosus (Selys)	31
TOTAL	79

Discussion

The observations made during this study show that predation by *Bembix* spp. on Odonata, particularly damselflies, is geographically widespread in Australia (Wheeler and Dow 1933, Evans and Matthews 1973, Evans *et al.* 1982) (Fig. 1). They also lend support to the proposal that some *Bembix* spp. may be obligate specialists on Odonata (damselflies), rather than the latter being alternative prey for polyphagous species that mostly feed on Diptera. Although there are insufficient data on prey for the genus to make definitive statements about prey group specificity, the detailed studies of Evans and Matthews (1973) and Evans *et al.* (1982) on the Australian fauna provide information on 27 of 82 described species. All except three of these 27 species specialise on a single prey group, viz. Diptera, thynnine wasps, Apidae *s.l.* (Colletinae, Halictinae, *Trigona*) myrmeleontid lacewings and Odonata. The exceptions are: *B. variabilis*, which preys mostly on Diptera but at two localities has been observed to also prey on damselflies, either exclusively (Kununurra) or in combination with Diptera so that brood chambers are provisioned with both prey groups (Darwin); *B. allunga*, which also mostly preys on Diptera as well as ascalaphid, chrysopid and myrmeleontid Neuroptera and libellulid dragonflies; and *B. moma* Evans & Matthews, the nests of which usually contain a mixture of prey groups

comprising to date three subfamilies of Apidae *s.l.*, five families of wasps (Ichneumonidae, Gasteruptiidae, Tiphiidae, Pompilidae, Sphecidae) and at least five families of flies (Evans and Matthews 1973).

The elongate brood chamber described here for *B. minya* (Fig. 2) is somewhat atypical for Australian *Bembix* in that most species construct a short chamber (Evans and Matthews 1973). However, at least one other species, *B. variabilis*, also constructs a similar elongate chamber which is undoubtedly necessary to accommodate the elongate bodies of multiple damselfly prey.

Clearly, *Bembix* spp. provide an ideal group to examine the evolutionary pathways that have led to prey switching. There is already some evidence that prey specificity is an evolutionary (fixed) trait in that the three species which exclusively prey on bees are contained within a single (presumably monophyletic) species-group. Further, the two species apparently restricted to damselflies, *B. minya* and *B. coonundura*, are closely related (R.W. Matthews, pers. comm.) and may be sister taxa. A prerequisite for such evolutionary studies would be the generation of a robust phylogeny for the Australian species, a not insurmountable task but one that would probably require molecular techniques given the likely level of morphological homoplasy within the genus.

The observations reported here are consistent with those documented for *B. coonundura* in regard to the number of damselflies provisioned per nest, and for this species and *B. variabilis* for nest structure. The three intact nests of *B. coonundura* excavated by Evans and Matthews (1973) at Lake Violet each contained about 10 damselflies, comprising two of the four species recorded here for *B. minya*, viz. *Xanthagrion erythroneurum* (Selys) and *A. annulosus*. This number and that recorded for *B. minya* are substantially lower than for the larger numbers of smaller flies recorded from nests of some *Bembix* spp., which often number in excess of 50. *Bembix coonundura* and *B. minya* presumably expend less energy in foraging for a smaller number of prey and this may explain why a single wasp was collected from the Wistow site; i.e. with fewer prey required it is possible for one wasp to provision multiple nests sequentially in a relatively short period of time, given that prey abundance is not limiting.

Finally, although the information presented here was the result of a fortuitous encounter, this study has revealed the potential for using artificial sand piles for observing and recording the nesting behaviour of *Bembix* spp. and other sphecids. At sites where soil types are mostly inappropriate for nest construction by sand wasps, artificial sites could be provided using sand of different coarseness to examine the effect of particle size on nesting success. Artificial sites provided at various times would also allow for the collection of data on seasonality in nesting and its effect on species composition of prey, plus rates of colonisation by different species.

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